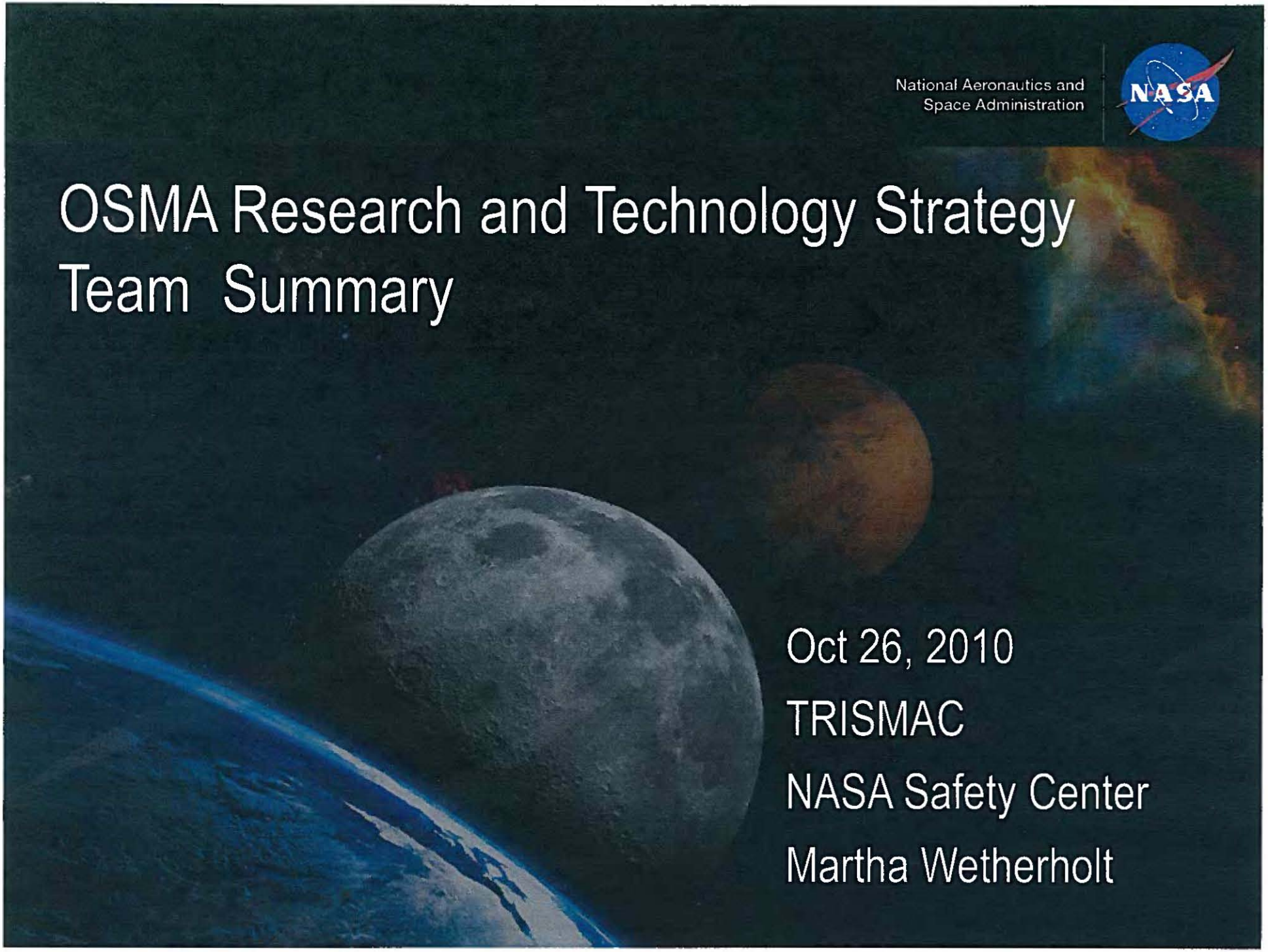
National Aeronautics and
Space Administration
NASA
OSMA Research and Technology Strategy
Team Summary
Oct 26, 2010
TRISMAC
NASA Safety Center
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ORTS purpose statement

Ensure the success of current and future Research and Technology Development Efforts. *(Even when "success" may be learning from a failure of the particular science or technology under study.)*

Contents

- Charter Overview
- TRL Discussion
- Executive Summary
- Defining Questions
- Challenges
- Summary

ORTS Charter

The OSMA Research and Technology Strategy Team shall:

- Look for new or streamlined approaches to provide risk information to Research and Development (R&D) researchers. NASA's Safety and Mission Assurance (SMA) community must provide input to R&D efforts in a manner which helps to build safety, quality, and reliability into new technology development without impeding progress. Consider any differences in approaches that may be needed for R&D in specific areas; e.g., aeronautics, ground operations, robotics, modeling and simulation, space flight.
- Benchmark NASA successes in this area as well as other government agencies and possibly industry (e.g., Department of Defense, Federal Aviation Administration, auto industry, aviation industry, and ***Defense Advanced Research Projects Agency***) and seek out strategies for incorporation of Safety, Reliability, and Quality Assurance (SR&QA) into the research and technology processes. This may include:
  - types of SR&QA requirements levied on Principle Investigators and/or test rigs and facilities
  - assessment and evaluation of risks associated with proposed tests and or demonstrations.
  - level of SR&QA oversight provided (or not)
  - participation in design reviews and acceptance reviews
  - process for verification and validation of requirements
  - process for testing
  - process for acceptance of risk

ORTS Charter (Cont.)

- Provide strategies for supporting upgrades and certifications for test cells, facilities, and test areas to support demonstrations and prototype tests.
- Provide strategies for better supporting simulations and model development.
- Provide SR&QA approaches needed for transitioning from prototypes to actual development activities with operational products and systems.
- Identify possible opportunity areas for future SR&QA research including tools development and process improvement.

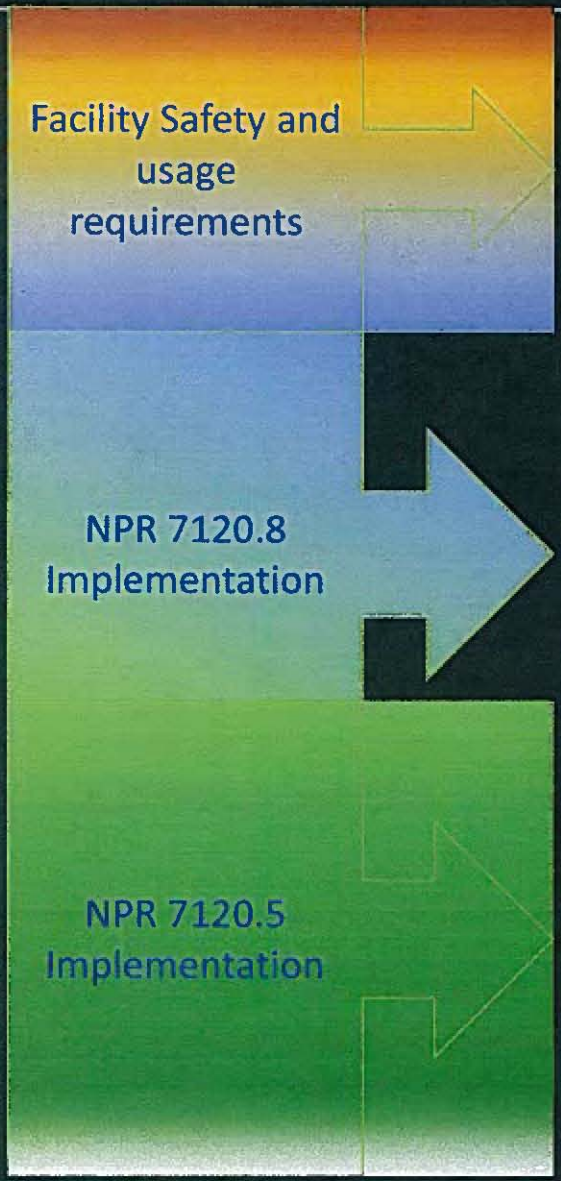
ORTS Team Process Overview

- Bi-monthly to weekly Telecon/Web-Exs with discussions, minutes, and action items
- Created and used PBMA Secure Site
- Membership including SMA Center representatives w. R&T experience, HQ OSMA, OSMA Tech Fellows, and researchers
- Reached out to Center researchers to gain better understanding of their perspective
- Reviewed current policies
- Benchmarked internal and external SMA needs and processes for R&TD
- Discussed with OCT their expectations vs SMA's of SMA's role
- Worked with OCT to understand their needs and perspective
- 2 face to face working meetings, at start and to finalize work and interviews
- Some Center Technology Road Maps examined and discussed to help define SMA roles
- Gathered LL and both success and failure Stories from past research efforts.

NASA Technology Readiness Levels

- **TRL 1** Basic Principles observed and Reported
- **TRL 2** Technology concept and/or application formulated
- **TRL 3** Analytical and experimental critical function and/or characteristic proof-of-concept
- **TRL 4** Component and/or breadboard validation in laboratory environment
- **TRL 5** Component and/or breadboard validation in relevant environment
- **TRL 6** System/subsystem model or prototype demonstration in a operational environment (ground or space)
- **TRL 7** System prototype demonstration in an operational environment
- **TRL 8** Actual system completed and "Flight qualified" through test and demonstration (ground, airborne or space)
- **TRL 9** Actual system "flight proven" through successful mission operations

2 General, Graduated SMA Coverage



Technology Readiness Levels Summary:

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Center Institutional Safety Requirements
- •High Risk Test Facilities
- •Labs
- •OSHA
- •Industrial Hygiene
- •Fire/Life Safety
- •Emergency Preparedness

•Awareness and insight both ways

Project dependent,
*Area targeted for SMA improvements

NASA and Center SMA Requirements
- •System Safety
- •Quality Assurance
- •R&M
- •Software Assurance
- •Risk Management

TRL Level Discussion

- TRLs 1-3: mostly paper concepts/theories, simulations, possibly Facility or bench top
  - SMA informs PMs, PIs of risk concerns and process, thinking ahead to safety, quality, & reliability needed for moving to demonstration phase
  - SMA becomes informed about the work in progress so can prepare if moves forward
- TRLs 4-6: use of Facilities and some experimental build up, proof of concepts, where decision to go to flight demonstration is made
  - SMA informs PMs, Engineers and Scientists of potentail risks, quality, safety and reliability expectations especially if use of our facilities but also general safety expectations
  - SMA participates on varied basis based on need/risk which has to be assessed individually
  - SMA gains insight and prepares for possible advancement of technology
- TRL 6-9: Flight or Ground Demonstrations
  - Project and SMA meet 7120.8 and/or 7120.5 flight development requirements for engineering and SMA

Executive Summary: Findings

Findings:

1. Agency Safety & Mission Assurance (SMA) needs to develop a consistent yet flexible approach to supporting Agency Research and Technology (R&T) efforts which incorporates Lessons Learned and Best Practices from Centers, Government, & Industry
2. Area for greatest improvement in SMA involvement is OCT's Game Changing Technologies /TRLs 4-6.
   a) Lower TRL's, (theories, papers, models, etc.) SMA not needed or covered via strict safety rules for NASA on-site facilities
   b) Higher TRL's, Fight Demonstrations on NASA payloads & aircraft must meet NPR 7120.5.
3. SMA R&T approach not just based on TRLs, must consider level of risks to personnel, public, facilities, and major equipment, both current risks and potential future risks as the technology may move forward
   – Consider added SMA support in certain technology domains (e.g. fuels, nuclear, electrical, pressure vessels, biology, etc.); complexity; flight vs non-flight
4. Early involvement with R&T efforts and their sponsors (including OCT) is essential if only for awareness on both sides & to prepare to support later
5. Education needs to go both ways: SMA to R&T and R&T to SMA

Executive Summary: Recommendations

Recommendations:

1. Create targeted guidance and training:
   a) For SMA personnel: understanding and discernment of R&T culture and needs
   b) For researchers and PMs of R&T: SMA support options, SR&QA and risk requirements awareness
2. Updates to NPR 7120.8, NPR 7120.5 and OSMA polices for better coverage of TRLs 4-6
3. Updates to NPR 7120.8 to better incorporate/ involve SMA awareness and consideration in early TRLs (from conceptual phase to finish)
4. Need multi–tiered points of contact established to better partner with OCT, Mission Directorates, and Centers with a focus on research and technology
5. Establish SMA as a key player in technology developments that are identified as having a stated purpose of improving SRM or QA characteristics
6. Fund OSMA from separate pot of money, i.e. CMO, for lower TRLs, so as not to impact research but still allow SR&QA the opportunity to gain awareness early on and provide training.

Executive Summary: Benchmarking Major Discovery

- **Biggest Surprise from Benchmarking:** National Labs, AFRL, & even DARPA (to some extent) have exceptionally well established, developed and implemented safety culture and SMA policies, i.e. everyone knows when, how, and who is responsible for involving SR&QA, new people are trained in it, PMs held accountable for it – it is the way they do business.

S&MA considerations for R&T Projects

(Right tools, right time, right extent)

- Criteria for determining S&MA level of involvement

  [e.g. Pure "paper studies" or data mining may not need S&MA involvement but awareness may still be needed]

  - Current TRL level
  - Difficulty scale to advance technology ("is it a hard nut to crack?"), complexity
  - Risks & risk tolerance (analyzing/managing uncertainties)
  - $$
  - Verifiable outcome
  - Damage likelihood
  - Impact of failed research (including public opinion)
    - Who cares and how much do they care?
  - Potential for future growth/development
  - Ability to test
  - Path to build with reproducibility
  - "Period of performance" drivers?

Defining Questions

- Questions for Researchers
  1. What are you trying to do? Articulate your objectives and explain the science and technology, please.
  2. Is there risk to the public, personnel, major NASA equipment, or Facilities?
  3. Could SMA support your efforts to assure that you can rely on the results of your investigations with: e.g. safety risk evaluation, calibration of measurement tools, contamination control, ESD control, configuration management, statistical design of experiments analyses
  4. If this technology eventually transitions to an operational technology for NASA, what Safety, Reliability, Maintainability and QA considerations may need to be addressed?
- Questions for SMA
  1. Do we understand what is trying to be accomplished for this experiment or development effort?
  2. Is there a current potential safety risk?
  3. Will S&MA involvement in the technology now be likely to reduce time, effort, and improve safety and "success"?
  4. What SRM and QA challenges may this technology or concept pose for SMA during development of the operational versions (TRL 8 and above) – so, what does S&MA need to do to be prepared to accept incorporation of this technology?
  5. Can SMA involvement help determine or improve the worthiness and acceptability of technology for infusion into Flight or Operational systems from a reliability, maintainability, safety and quality perspective?
  6. What is the potential for this technology to improve SRM and QA characteristics over the current State of the Art?

Challenges - Change the Paradigm

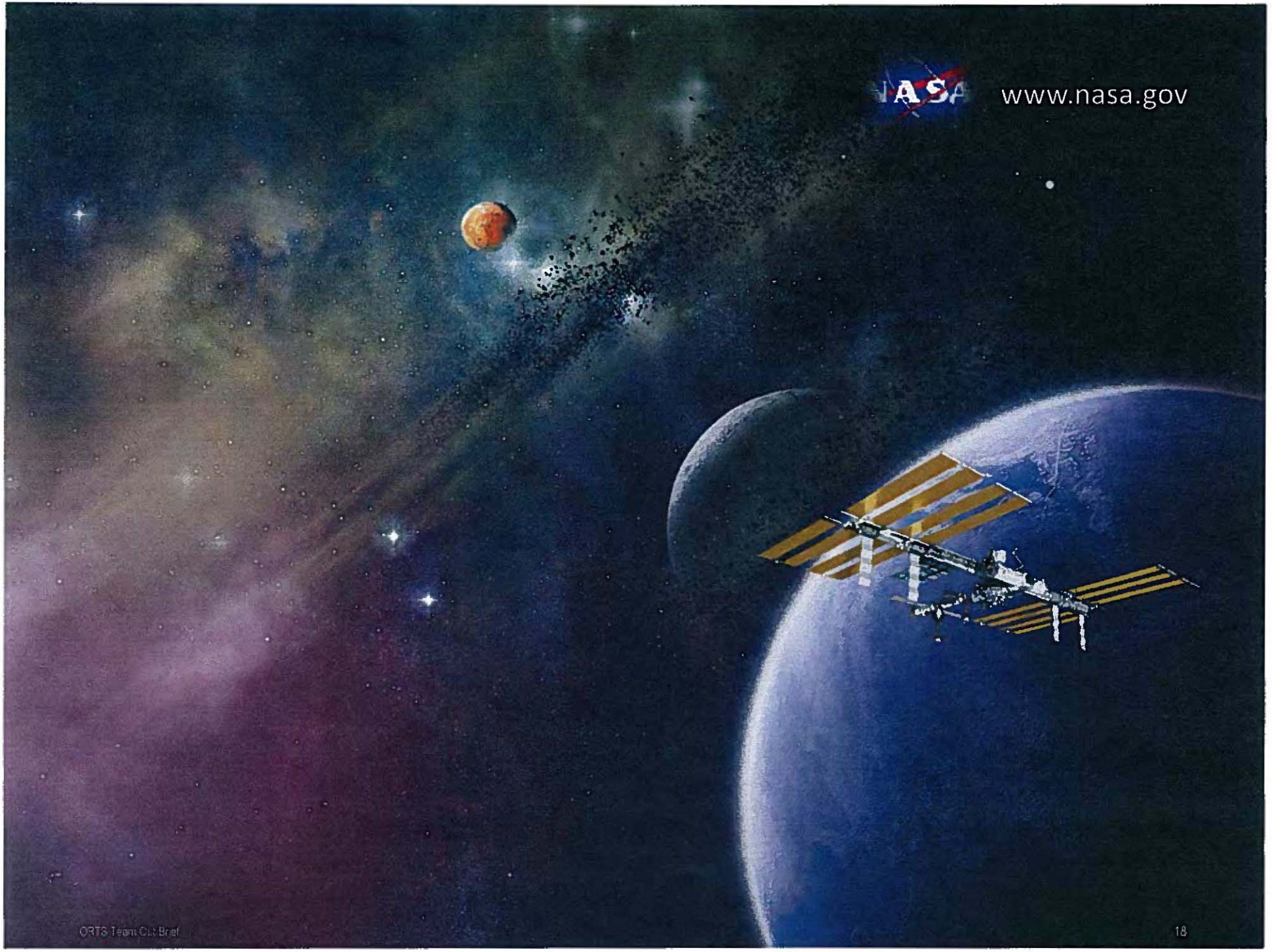
- Inconsistent approach to R&TD at Centers and now with OCT directions and terminologies
- Need to get visibility of OSMA requirements and processes in the project management documents, not just buried in our own documents
- R&T sees us as potential "road blocks" and have the misconception we are there to stop projects – SMA is seen as a having a "cop mentality"
  - We are seen as one size fits all
  - We are seen as being very costly and slow
- OCT wants to tell us when they think we should be involved, otherwise we should not be concerned with what they are doing
- We need early involvement and awareness to avoid becoming a roadblock at infusion.
  - We need to understand the science, technologies, complexities, and risks in order to advise the R&T (including OCT supported Projects) communities of what SR&QA can do for them.
- "Bringing SR&QA in" does not mean we are going to impose anything!!!!

Summary

- Many NASA processes already exist that cover much of what is needed for the lower and upper TRL levels, the mid level or "Game Changing" technologies though need improved approaches.
- TRL levels are not enough to determine SMA's roles and level of involvement
- Improved communication, understanding and cooperation is needed between SMA and OCT, the Mission Directorates, and Center Researchers and Technologists and the project managers of R&TD projects.
  - Improved SMA focus on R&TD via selected, multi-tiered POCs
  - SMA needs better awareness of and participation in research selection, w. focus on transition to flight demonstrations and eventual incorporation into NASA systems
- Other successful organizations have built a culture of safety and level of quality expectation in the facilities, projects, and personnel involved in R&T, for both internal and external projects. NASA can improve in this area as well. It does take time to instill this culture.

Summary (Cont.)

- We need to "Change the Paradigm" from Flight Orientation:
  - Create Training and Awareness Campaigns
    - Make sure Researchers are aware of the benefits of all aspects of S&MA contributions
    - Increase visibility and presence without the "cop" paradigm
    - Make sure S&MA personnel are aware of the differences in our roles and responsibilities in an R&T environment
    - Increase SMA visibility and presence without the "cop" paradigm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